Appendix C – Implementation Procedures

(Informative)

This section includes guidelines for placement of Framework Road Segments (FTSeg) and Framework Road Segment Reference Points (FTRP). It also describes recommended procedures for implementing this standard, conventions for cartographic display of FTRP and FTSeg, and conformance testing.

3 Implementation Procedures

The NSDI Framework Transportation Identification Standard imposes only one constraint with respect to how a physical road is partitioned into FTSeg: segments must not span state borders. This section therefore provides a set of guidelines for placing FTRP and creating FTSeg that are expected to meet the needs of a great many – but not all – of those organizations that wish to participate in sharing road information. These guidelines are intended to be compatible with the practices of organizations that support network applications and require connectivity of the links and nodes which correspond to the FTSeg and FTRP defined in this standard.

The procedures recommended in these guidelines are consistent with the level of detail found in maps at scales ranging from 1:12,000 to 1:24,000. Many transportation databases are being created at these scales by digitizing from USGS quadrangles or from standard Digital Orthophoto Quarter Quadrangles (DOQQs). This section offers procedures and rules of good practice intended for use at this scale: other users developing databases at smaller or larger scales may need to consider departures from these procedures. These procedures are specifically not applicable to users whose applications are based on CAD-scale engineering databases that graphically depict roadway widths, curbs, right-of-ways, etc.

FTSeg should be created to represent those segments of roads about which attributes (including cartographic shape) are to be shared among organizations. Segmentation of roads into links which are specific to particular network applications (e.g., driveway-to-driveway road segments for E-911 dispatch, shopping center parking lots for transit buses, or back alleys for trash collection) do not require FTSeg unless they have associated with them information useful to other users or applications.

Road data authorities should coordinate the development of a road data base with all relevant stakeholders, particularly with respect to which roads should be included in a local implementation. The decision of which roads to include should reflect a reasonable compromise between an economical number of FTRP and FTSeg, and common network application needs of the stakeholders. *Example: A local E-911 agency may wish to incorporate intersections of local roads with private driveways. However, such a data structure would proliferate the number of FTSeg in the road database. Unless other cooperating road data authorities agree that this structure is useful, they should place FTRP only at intersections of public roads; the E-911 agency can create a supplemental road database using explicit connectivity to join driveways to local roads.*

3.1 Cartographic Representation of FTRP and FTSeg

3.1.1 Display of County and State Density

The state to which each FTSeg record pertains is encoded within the unique identifier, as is the state in which an Authority operates (with some exceptions.) This information, plus the coordinates of FTRP, can be used to display general location and density of FTRP and FTSeg records.

3.1.2 Display of FTRP and FTSeg

3.1.2.1 FTSeg should be depicted either by straight lines connecting two FTRP or by curved lines (if two or more FTSeg terminate at the same two FTRP.) Each FTSeg should be displayed as a line terminating in a single "arrow-head" at the "To-FTRP" terminus. Various line symbols and widths may be used. More realistic cartographic representation of FTSeg requires that they be linked to table(s) of attributes which include the coordinates of shape points.

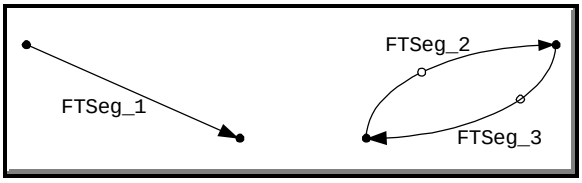

Figure 10 – Cartographic representation of FTSeg

3.1.2.2 Coordinate values (horizontal) and related accuracy statement fields are required within each FTRP record. Availability of this information will allow the cartographic display of point locations along with information about the known

accuracy of each. FTRP should be symbolized as one of three representations of circles.

3.1.2.2.1 FTRP which terminate one or more FTSeg, and through which no FTSeg pass without terminating, should be represented by a filled circle. Such FTRP indicate terminal connectivity.

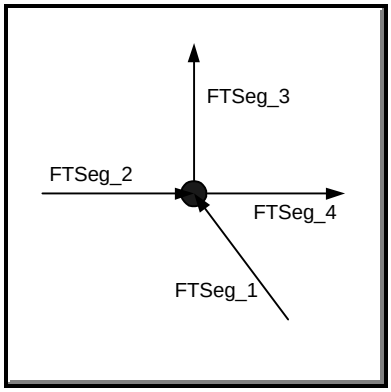

Figure 11 - Cartographic representation of terminal connectivity at an FTRP

3.1.2.2.2 FTRP which do not lie at the terminus of any FTSeg should be represented by an open circle; the lines representing FTSeg which pass through the FTRP should not be visible within the unfilled (opaque) center of the circle. Such FTRP might not indicate any FTSeg connectivity; e.g., they are used to indicate a unique Intermediate Point on an FTSeg. Alternatively, such FTRP might indicate implicit connectivity; e.g., two FTSeg cross at -- but do not terminate at -- an FTRP.

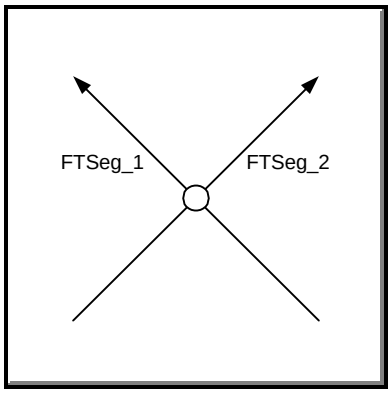

Figure 12 - Cartographic representation of no connectivity at an FTRP

3.1.2.2.3 FTRP which terminate one or more FTSeg, and through which one or more FTSeg pass without terminating, should be represented by an unfilled circle; the lines representing FTSeg which pass through or terminate at the FTRP should be visible within the unfilled (transparent) center of the circle.

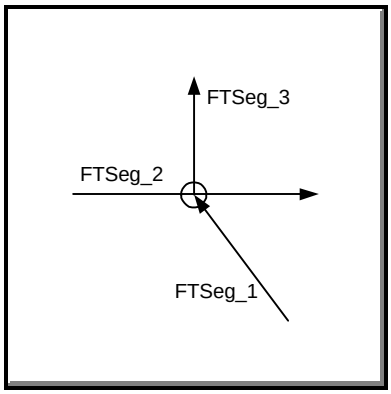

Figure 13 - Cartographic representation of mixed connectivity at an FTRP

3.1.3 Relationship to Other Cartographic Elements

FTRP and FTSeg identifiers will be encoded as attributes associated with lines and intersections within geographic information systems, and associated with links and nodes in network representations. Cartographic representations which utilize FTRP and FTSeg should be carefully symbolized, labeled and/or annotated so that users do not impute to the FTRP and FTSeg position or precision which is not warranted, or confuse them with links and nodes. FTSeg have no shape points or inherent geometry, and need not have a measured length. Users will associate them with arcs and chains contained within their datasets, and display them as such. Such display of FTSeg will be necessary during the process of their initial definition and subsequent updates, and will be helpful to many users.

3.2 Establishing Framework Road Segment Reference Points (FTRP)

3.2.1 At Jurisdictional Boundaries

FTRP should be placed wherever a road crosses a jurisdictional boundary between two road data authorities. The road data authorities on either side of the jurisdictional boundary should coordinate the identification and placement of the FTRP so that one common FTRP is used to identify the crossing point. *Example: Two neighboring states should coordinate identification of FTRP at their common boundary with each other and with contiguous counties and/or other jurisdictions (where pertinent) who share the same boundary line(s).*

3.2.1.1 State and International Borders

FTRP must be placed wherever a road crosses a state border, regardless of whether or not there is a designated road data authority in the adjoining state or country. Such FTRP should terminate FTSeg representing any road which intersects the border.

3.2.1.2 County Boundaries

Authorities should consider placing an FTRP wherever a road crosses the boundary between two counties within a state. Even in those cases where the delineation of a

county boundary is not easily located in the field, placement of an FTRP could facilitate coordination with authorities and road data users on either side of the boundary.

3.2.2 Simple Road Intersections

An FTRP should be placed wherever two roads of similar functional class or importance cross one another at grade. Roads segments which share a common FTRP are connected terminally or explicitly; therefore no additional information is required in order to establish connectivity in any application network built from the road data. Road data authorities should identify those roads for which they want to ensure connectivity in all network applications and place FTRP at each intersection.

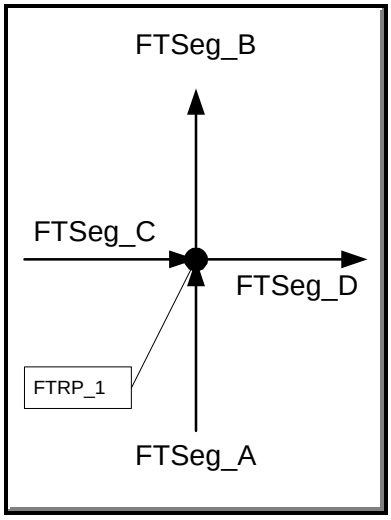

Figure 14 - Simple Road Intersection

Example: A state DOT may wish initially to construct a statewide road base map, consisting only of state highways, U.S. routes and Interstate highways. FTRP would be placed only at the intersections of these roads. Intersections with county and local roads could be accommodated at some future time through explicit connectivity to FTSeg on the statewide road base map.

A single FTRP can be created to represent the intersection of two or more roads; it can be used to terminate all segments of intersecting roads (illustrated in Figure 14 as terminal connectivity of segments FTSeg_A, B, C, and D.)

In addition, a single FTRP can be created to represent an intersection of two or more roads where not all segments of intersecting roads terminate (illustrated in Figure 15 as explicit connectivity of segments FTSeg_E, F, and G.) A cartographic convention used in this figure places an arrow-head at FTRP_2, where the FTRP breaks the "east-west" road into two segments[6]. FTSeg_G passes through the same point unbroken, as is indicated by the lack of an arrow-head at FTRP_2. FTRP_2 provides terminal connectivity between the two segments for which it serves as a terminus. If it also serves to connect one or more terminated segments to an unbroken segment, then the FTRP data record also provides for explicit connectivity to the unbroken other segment – illustrated as FTSeg_G.

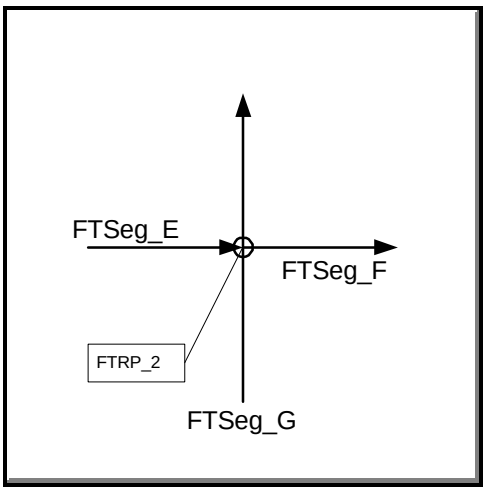

Figure 15 Simple Road Intersection

3.2.3 Offset Intersections

[6]See Implementation Procedures – Section 1.1 for recommenced cartographic conventions.

Occasionally, one road may intersect another at two distinct intersections offset by a short distance**.** In order to avoid creating a very short FTSeg, road data authorities should use an FTRP to represent explicit connectivity at only one of the intersections. Depending on the level of spatial resolution represented in the road database, the second (offset) intersection may be joined using explicit connectivity, or the offset distance may be ignored and treated as a conventional at-grade intersection.

3.2.4 Overpasses and Underpasses

FTRP may be placed at grade-separated crossings such as overpasses or underpasses in order to meet several needs. First, if placed at such a crossing the FTRP could represent the terminal connectivity of two segments which terminate on the upper grade or the lower grade. Similarly, if segments terminate on both roads, two separate FTRP should be used to represent connectivity at the upper and lower termini. Finally, an FTRP can be placed at such an intersection and not serve as a terminal point of any segment; i.e., it could serve only as an “intermediate-point” of one of the segments. In summary, placement of an FTRP at such a location requires users to provide additional information in any network applications, so that users do not make unsupported assumptions about implicit connectivity.

3.2.5 Grade-Separated Interchanges

Grade-separated interchanges consist of one or more overpasses, and entrance and exit ramps to connect the otherwise non-intersecting main roads. In general, an FTRP does not need to be placed at the location of the overpassing roads if network connectivity can be established using the ramps. However, road data authorities may wish to place FTRP at interchanges in order to create manageable length road segments. *Example: On limited-access highways a state DOT may choose to establish FTSeg that go from interchange to interchange.*

If an FTRP is placed at a grade-separated interchange, it should only connect one of the two crossing roads, not both. In other words, the FTRP should serve as the end point for only two FTSeg, either the over passing road or the under passing road, but not both. If the transportation data authority chooses to segment both roads at the interchange, two unique FTRP should be created, one connecting the over passing road, and one connecting the under passing road. These FTRP may either be assigned the same X-Y coordinate values, or may be offset from one another.

3.2.5.1 Entrance and Exit Ramps

An FTRP should not terminate a segment of a road at every gore point (i.e., intersection) where the road is joined by entrance or exit ramps. To do so would divide the road into a large number of very short FTSeg in the vicinity of the interchange. Entrance and exit

ramps are better handled using explicit connectivity to join the end point of the ramp to the main road at some specified offset distance along a segment of the road**.**

3.3 Establishing Framework transportation Segments (FTSeg)

A single FTSeg represents an unambiguously defined path along a physical transportation network between two FTRP. In most instances, FTRP can and should be selected in such a way that there is only one path between them along a transportation network In cases where two or more uninterrupted paths exist between the same two FTRP, the fields for Intermediate-Point and Path-Description in the FTSeg record must be used to differentiate among the paths. Transportation data authorities with overlapping responsibilities for a geographic area should coordinate the identification of FTSeg. *Example: A state DOT and a county road authority are both responsible for building a road framework data base for the county. The technical staff for each agency should agree on which agency has responsibility for identifying FTSeg of which roads (e.g., the state DOT authority designates FTSeg for all Federal and state sign routes, while the county authority designates FTSeg for all county routes and local roads).*

3.3.1 Segment Length

The appropriate FTSeg length represents a tradeoff between maintaining information on a large number of short segments, and potential errors introduced by measurements over a long linear segment. This standard prohibits segments which span boundary lines of states, territories, or equivalent jurisdictions. Transportation data authorities within a particular geography will need to assess whether more restrictive guidelines regarding FTSeg length are needed to support common applications among various transportation database users within that geography.

3.3.1.1 Roads that Cross Jurisdictional Boundaries

Roads that cross state and county jurisdictional lines should be represented by FTSeg that terminate at the boundaries. Consequently, no FTSeg should be longer than the driving distance across a state; in all but the most rural areas, authorities should consider terminating FTSeg at county boundaries.

3.3.1.2 Roads that Coincide with Jurisdictional Boundaries

Roads which run along a jurisdictional boundary should be represented by FTSeg whose length does not exceed the line dividing the jurisdictions. When a road runs along a jurisdictional boundary for a portion of the boundary length, an FTSeg should be terminated where it leaves the boundary line, and a new FTSeg should be initiated –

except in locations where local authorities determine that the departure from the boundary line is insignificant. Part III-D of this standard provides an example.

3.3.2 Road Types

The decision to represent a particular road by a single FTSeg or two (or more) parallel FTSeg should be based on scale, accuracy, cartographic and network application requirements. In general, network applications are facilitated where FTSeg and FTRP can be directly replaced by network links and nodes. These guidelines are aimed at minimizing additional work beyond establishing explicit connections for FTSeg to create a flowable transportation network.

3.3.2.1 Roads with no Access Restrictions or Medians

One-way and two-way roads with no significant access restrictions or physical median separating directional roadways should be represented by a single FTSeg. Most local streets, connectors, and minor arterials fall into this category.

3.3.2.2 Roads with Center Medians but no Access Restrictions

Some major urban and rural arterials have a center median which divides the travel lanes in each direction (e.g., Commonwealth Avenue in Boston). However, intersecting streets can access either direction of travel lanes via short transportation segments crossing the

median at each intersection. These roads may be represented either by a single FTSeg which ignores the center median, or by two parallel FTSeg depicting directional roadways on either side of the median. If parallel FTSeg are used, intersecting FTSeg should be terminated at only one of the two parallel FTSeg, not both.

3.3.2.3 Limited-Access Divided Highways

Most Interstate Highways and major, high speed expressways can only be entered or exited via specifically designated ramps. These roads almost always have some median strip or other physical barrier that prohibits vehicles from reversing direction without first exiting the highway at a designated ramp. These roads should always be represented by two FTSeg regardless of the actual physical separation between the lanes (e.g., even roads which are separated by a concrete “Jersey Barrier” should represented by two FTSeg if each direction is served by its own entrance and exit ramps.)

3.3.2.4 Physically Separated, Limited-Access Parallel Lanes

Some high volume roads, particularly in urban areas, may designate certain lanes for high occupancy vehicles (HOV) or auto-only, and physically separate these lanes from the main travel lanes (e.g., I-395 in northern Virginia, or the New Jersey Turnpike outside New York City). If these physically separated lanes are served by their own entrance and exit ramps, they should be represented by their own FTSeg. Furthermore, if the priority lanes

are also separated directionally, each direction should be represented by its own FTSeg. *Example: The northern end of the New Jersey Turnpike includes physically separated auto-only lanes, running parallel to the main traffic lanes in both directions. Both the main lanes and the auto-only lanes have their own entrance and exit ramps. This facility should be represented by four parallel FTSeg – one for each direction of the main lanes and one for each direction of the auto-only lanes.*

3.3.2.5 Entrance and Exit Ramps

Entrance and exit ramps are one-way or two-way roads that provide general vehicle access to limited-access highways. Each entrance or exit ramp should be represented by an FTSeg. FTRP which terminate entrance or exit ramps should use explicit connectivity to join with the main road which the ramp accesses.

3.3.2.6 Frontage Roads

A frontage or access road is a one- or two way, unlimited-access surface street that parallels but is physically separated from a more limited-access major arterial. Its main purpose is to provide access to establishments along the major arterial corridor while preventing access traffic from disrupting the flow of through traffic on the major arterial. Access from the frontage road to the major arterial is typically limited to intersections of cross-streets and/or specifically designated “gaps” in the median or physical barrier.

Frontage roads should be represented by their own FTSeg. Entrance "gaps" between the frontage road and the main arterial should be treated similar to an entrance or exit ramp.

3.3.2.7 "Stacked" Highways

A stacked highway occurs when one road or directional roadway is built above another roadway. Although the two roads are separated vertically, when displayed on a two-dimensional surface (e.g., map or computer monitor) they appear as a single line. Each road or directional roadway should always be represented by its own FTSeg, regardless of how they might be displayed.

3.3.3 Complex Intersections

The preceding guidelines provide rules for placing FTRP and using FTSeg to represent various types of transportation features in a generally consistent way and without creating short, difficult to locate FTSeg. The following examples illustrate some typical combinations of roads and intersections and how they might be represented using FTRP, FTSeg, and explicit connectivity relationships.

3.3.3.1 Full Interchange, Two Limited-Access Divided Highways

The classic "cloverleaf" interchange and its assorted variations of ramps provides network connections between two crossing, limited-access divided highways such that there exists

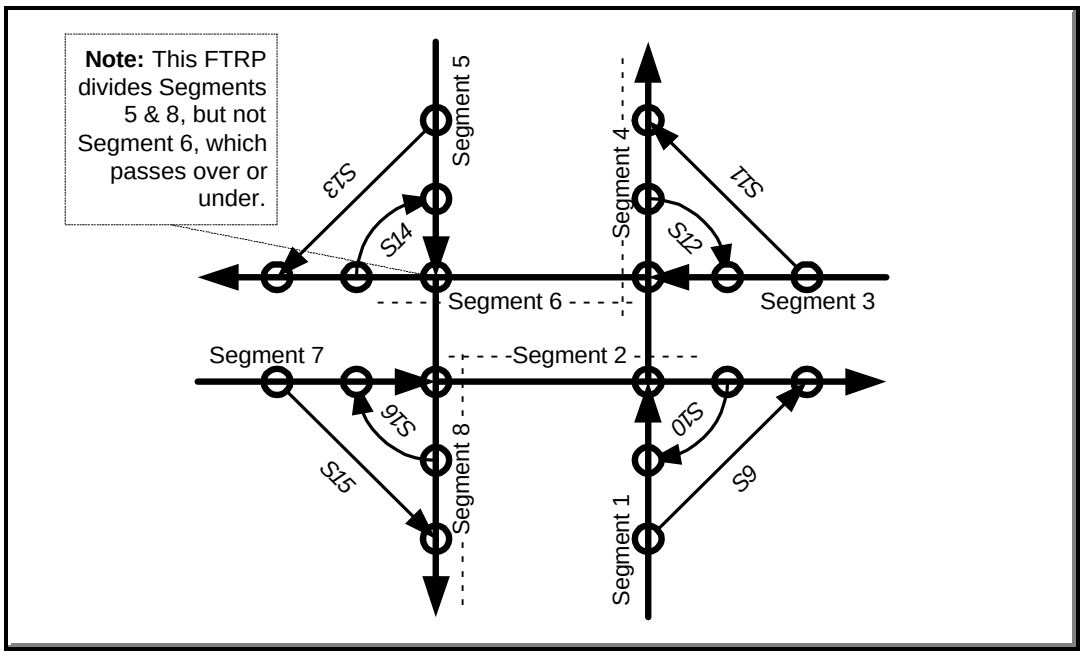

Figure 16 Full Interchange, Two Limited-Access Divided Highways

a valid network connection from any directional roadway to any other roadway. Each directional roadway should be split only once within the interchange. This can be done by splitting each incoming directional roadway where it first crosses (either as an overpass or underpass) a directional roadway of the other highway. Only the incoming FTSeg is split; the FTRP does not split the crossing directional roadway at this point; the "Note" in Figure 16 highlights this. The resulting configuration consists of four FTRP, one at each of the four corners of the intersecting directional roadways. However, each of these

FTRP connects only two of the four apparently intersecting lines. Ramps are added to the interchange using explicit connectivity to join each endpoint of the ramp to one of the directional roadways of the crossing highways. The resulting interchange consists of eight FTSeg for the main highways (each of the four directional roadways is split into two FTSeg), and up to eight FTSeg for the interchange ramps.

3.3.3.2 "Diamond" Interchange

The classic "diamond" interchange provides a network connection between a limited-access divided highway and a two-way surface roadway. On the divided highway, each directional roadway should be split where it crosses (either as an overpass or underpass) the two-way street. As with the full cloverleaf interchange, the FTRP on the directional roadway does not split the crossing two-way street. The two-way street should be split either by a second FTRP assigned the same X-Y coordinate values as one of the two FTRP of the directional roadways, or by an FTRP located "between" the two directional roadways, as illustrated

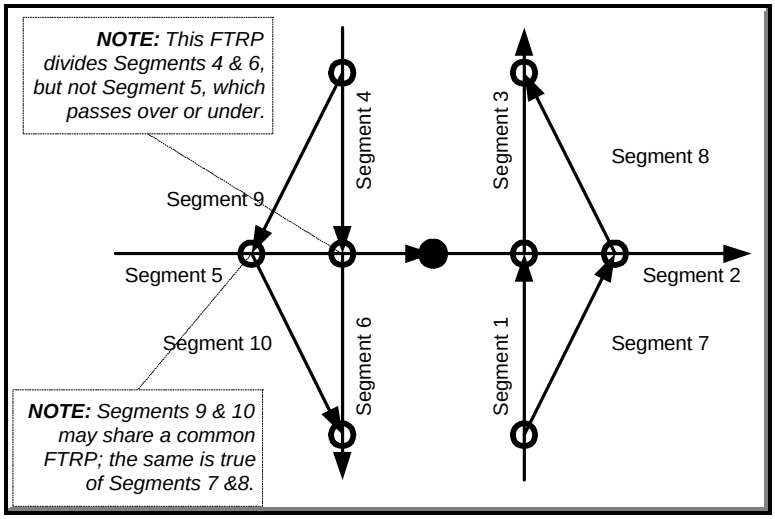

Figure 17 - "Diamond" Interchange

above. Ramps are added to the interchange using explicit connectivity to join one endpoint of the ramp to one of the directional roadways of the divided highway and the other endpoint to a location on the two-way roadway. The resulting interchange consists of six FTSeg for the crossing roads, and four FTSeg for the interchange ramps.

3.3.3.3 Intersection: Two-Way Surface Street with a Center Median Surface Street

This intersection looks similar to the "diamond" interchange, except that there are no overpassing roads: the two-way crossing street actually intersects each directional roadway. In order to avoid creating a very short FTSeg representing the road surface crossing the median area, a single FTRP should be placed at one of the two intersections that splits both the crossing two-way roadway and one of the two directional roadways. This is labeled as "FTRP-2" in Figure 18. The other directional roadway should be split with an

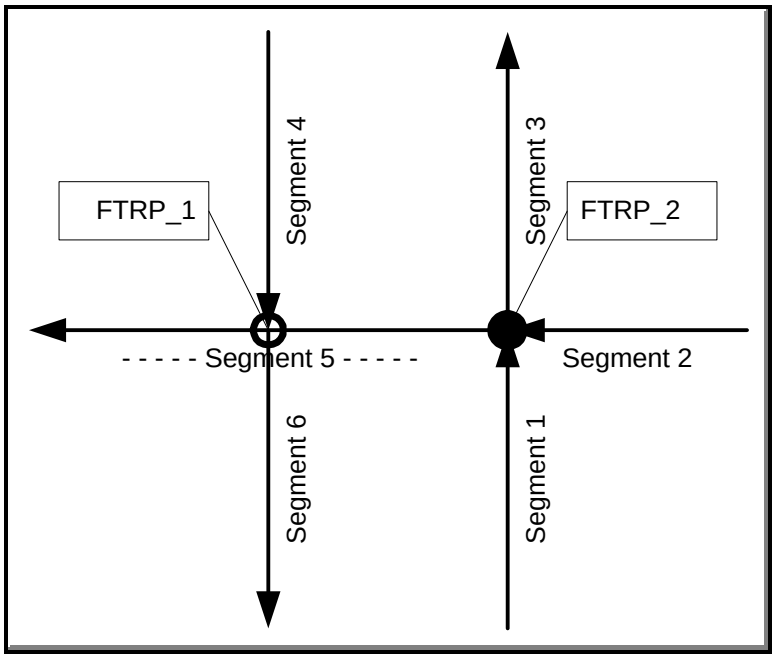

Figure 18 - Intersection: Two-Way Surface Street with a Center Median Surface Street

FTRP -- labeled as “FTRP-1" -- that indicates explicit connectivity to the FTSeg that represents the crossing two-way road. The resulting intersection consists of six FTSeg and two FTRP.

3.3.3.4 Traffic Circle

A traffic circle consists of a circular loop road that is intersected by several other roads which radiate outward from the circle. The traffic circle should be represented either as a single FTSeg that begins and ends at the same FTRP (illustrated in Figure 19), or by two FTSeg that each represent some portion of the circle. The FTRP marking the intersection of each radiating road should be connected to the traffic circle FTSeg using explicit connectivity to avoid creating short FTSeg between each radiating road. The path description for the FTSeg representing the traffic circle should include a direction (either clockwise or counterclockwise) to indicate the order in

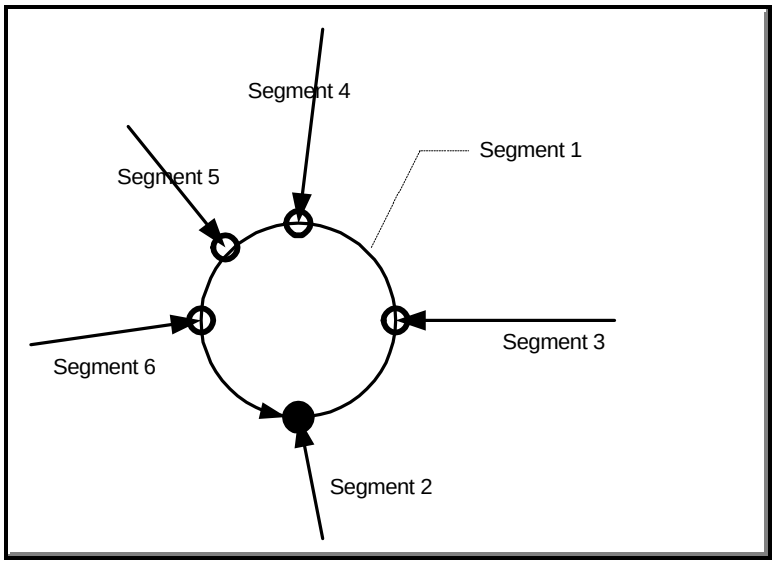

Figure 19 - Traffic Circle

which the radiating roads intersect. One of the radiating roads may share the same FTRP as the traffic circle FTSeg.

3.4 Creating New or Updated FTSeg and FTRP

Multiple FTRP and FTSeg records can exist for any point or segment, because their multi-part key includes "Authority-ID" and "Date". *"Creating"* FTRP and FTSeg refers to generating a record keyed with a new and unique FTRP-ID or FTSeg-ID. *"Updating"* FTRP and FTSeg refers to creating a new database record for a previously-identified FTSeg or FTRP. Each "update" record will utilize an already-defined FTRP-ID or FTSeg-ID, and use a new and unique combination of "Authority-ID" and "Date" information.

In the normal course of events authorities will update records to reflect improvements in description or measurement for the same point or segment – even if there is no change in the "real world" features represented by the FTRP or FTSeg. Older database records are retained in the index along with the database records which reflect "updates" to non-key information fields.

3.4.1 Road reconstruction

New FTRP and/or FTSeg records must be created when FTRP are relocated and FTSeg are re-defined during the (re-)construction of roads or changes in intersection alignment. This requires retirement of old FTRP and associated FTSeg, and creation of updated FTRP and FTSeg, as described below. The unique identifier for FTRP and/or FTSeg records which are retired as a result of (re)construction may be encoded within other records to which the retired objects are topologically connected. Affected records may occur in FTRP and FTSeg tables, as well as the Connectivity and Equivalency tables. Therefore the references in these other records must be updated with the identities of the objects which have replaced the retired objects, or the records must be retired.

3.4.2 Re-measuring

FTRP and/or FTSeg records should be updated when more accurate measurement of coordinates/lengths are obtained. This entails creating new records with a unique key made up of the FTSeg-ID and/or FTRP-ID, the Authority-ID, and the Date, updating the information in other fields (as appropriate), and carrying forward information from fields which are not updated.

3.5 Retiring FTSeg and FTRP

3.5.1 Road reconstruction

As stated above, new FTRP and FTSeg should be created during the construction or reconstruction of roads; e.g., addition of ramps, or changes in intersection alignment. Those FTRP and FTSeg used exclusively to designate the (old) feature which has been reconstructed should be retired by changing the "Status" of all records which identify the (old) feature from "A" (active) to "R" (retired).

3.5.2 FTRP Duplication

Instances can occur in which two authorities create unique FTRP IDs which identify the same "real world" feature.

3.5.2.1 Before identifying new FTRP each authority should evaluate existing FTRP records maintained in the distributed index, and should coordinate with other authorities concerned about the same or contiguous geography, in order to prevent such duplication. Analysis of the"AAAAA" substrings and the coordinates of existing FTRP identifiers will in most cases allow an authority to avoid duplication.

3.5.2.2 When authorities verify that duplicate FTRP-IDs exist for the same feature, they should retain the unique ID which has the earliest date of assignment. All FTRP and FTSeg records which contain a duplicate ID should be retired by changing their "Status" to "R" (retired). Any useful information which is contained

within these (retired) records should be copied into active records that contain the ID which has been retained, and that are identified uniquely as to "Authority-ID" and "Date". *Example: Two neighboring jurisdictions use and update two different road base maps, and have not coordinated activities in the past. They independently identify FTRP that describe identical "real world" features at their shared border. They should review coordinate and description data in order to select and analyze possible duplicates, whether at the level of a sub-county border, a county border, or a state border. They should retain the oldest of each set of duplicate records as "active," update these with any useful information from records which are to be retired, and change the status of newer duplicate records to "retired."*

3.6 The Distributed Index of Transportation Authorities, FTSeg, and FTRP

3.6.1 Transportation Authorities

Part II of this standard describes the role of NSDI Framework Transportation Authorities and the coding of a unique identifier and attributes for each. Designation as an authority is voluntary and self-initiated by any organization which performs the role(s) described.

3.6.1.1 Initial Assignment and Maintenance

The initial assignment and maintenance of each unique authority identifier will be performed by the FGDC or one of its participating agency. These functions will be implemented within a WWW-based software application providing for data entry and validation, assignment of an ID and password, and search and download functions.

3.6.1.2 Access

Provision of access to the indexed database of authorities and the public dissemination of information about each authority will be the ongoing responsibility of the FGDC or a participating agency. Access and information about authorities will be available through the WWW and in printed form.

3.6.2 Points and Segments

Part II of this standard describes the specification of Framework Road Segments and Framework Reference Points, and the coding of unique identifiers, the record structure, and attributes for each. This section describes the procedures by which records describing each point and segment are established, maintained, and made accessible to the public.

3.6.2.1 Initial Assignment (Creation) and Maintenance of FTSeg and FTRP Records (voluntary & distributed)

The FGDC or one of its participating agencies will implement a WWW-based software application providing for data entry and validation, assignment of an ID and password, and search and download functions. This database application will operate in a fashion very similar to the FGDC Metadata Clearinghouse application.

The index will operate on a central server(s), and the same application will be provided to Authorities who wish to provide their own indices of FTSeg and FTRP. The data will be maintained on this decentralized network of servers – each authority need not operate the application; multiple Authorities can cooperate in hosting the application. Search, display and download functions will be publicly accessible. Each Authority will have the secure ability to make add-update transactions for records containing its unique Authority-ID. Any Authority will have the ability to create uniquely-keyed "update" records relating to an FTRP or FTSeg which has been defined previously.

3.6.2.2 Access

Provision of access to the indexed database of FTSeg and FTRP, and the public dissemination of information about the data will be the ongoing responsibility of the FGDC or a participating agency, and of participating Authorities. Access and information about FTSeg and FTRP will be available through the WWW and in printed form.

3.7 Defining FTSeg and FTRP within a Geographic Area

The implementation of this standard requires development of consensus among a limited number of authorities who create and update transportation data within a specified geographic area. Those participating will have a thorough knowledge of NSDI Framework principles and roles, and will likely be performing several of the identified functions of Framework management. The tasks that they will have to accomplish in order to implement this standard are summarized below.

3.7.1 Geographic Extent

Implementation of the standard should be attempted within an explicitly bounded geographic area consisting of one state, or a sub-state area. The extent of this area must be determined by all organizations which may wish to share data within the area, or to become cooperating authorities. Often the choice made will be closely linked with the following task.

3.7.2 Cooperating Authorities

All organizations which develop or maintain road centerline databases should be informed of efforts to implement the standard, and should be invited to participate. Agencies of the U.S. Departments of Interior, Transportation, Commerce, and others may want to participate, depending upon the geographic area. It is likely that successful completion of

this and related tasks depends upon the willingness of one organization to assume a leadership role in gaining the cooperation of others. Each participating organization should recognize that the incentive to incur the workload of implementation consists of future enhancements in its ability to share data which supports key business functions, and consequent reductions in the costs of sharing data.

Those organizations that agree to implement the standard should make their commitment explicit, and should determine that the institutional relationships required for data sharing with others are or can be put in place. Other organizations which operate applications that require or would benefit from improved sharing of transportation data – but which do not actually develop or maintain data – should also be informed. No commitment is required from these other organizations.

3.7.3 Contiguous Jurisdictions

Major state-level or sub-state data producers in contiguous jurisdictions should be identified and informed of efforts. The current status of data sharing operations at relevant jurisdictional lines should be assessed. When practical, organizations which might serve as authorities should be identified, and their cooperation in identifying FTRP at boundaries should be sought.

3.7.4 Inventory of Databases and Applications

Once the questions of "Who?" and "Where?" have been addressed, participants should inventory all transportation database development and maintenance operations which will be affected by the implementation of the standard. Participants should also inventory the applications which depend upon the transportation data, and the value of the improved data sharing which is likely to result from use of the standard. Particular attention should be given to the networks which have been developed, their commonalities and differences. The common requirements of applications will lead authorities to determine whether or not county and/or local and/or private roads should be included in an initial implementation.

3.7.5 Base Data for Initial Assignment

Participants will have to examine available data assets to determine the extent to which nationally or locally available sets of names, points and lines, or links and nodes may provide a "starting point" for implementation. *Example: In a large rural area, locally-enhanced TIGER line file data and a "starter set" of points such as the ITS Datum Prototype Version 1.1 CD may provide the basis for determining the local scope of an initial implementation of the standard. In a more urbanized area where road names are well-known, used, and stable, a larger-scale local database which includes network nodes and links based on unique road names may be a better point for initial creation of FTSeg and FTRP records.*

3.7.6 Prototype Implementation

Within a limited section of the geographic area cooperating authorities should do a prototype implementation, utilizing this standard and other locally-developed guidelines for achieving FTRP densities and FTSeg spans that best meet their needs. All data records should be accorded the STATUS of "Proposed." All cooperating authorities should then attempt to embed the FTRP and FTSeg identifying information within their own data structures, determine any difficulties, and agree on refinements in the implementation. Following implementation of the prototype, cooperating authorities should determine the sequence and timing of operations to implement the standard within the geographic area selected. Authorities should populate identifying records in the Index of Authorities, and cooperators should identify the Index of FTRP and FTSeg which will be the registry for their information.

3.8 Establishing Object Identity and Connectivity

Each Framework transportation data developer will have to know some characteristics of multiple transportation databases which may be under development or maintenance within the developer's geographic extent, and those which may exist at the boundaries of that extent. The data developer will very likely want to implement this standard in such a way

as to assure that other users will be able to relate and connect their databases. *Example: In a particular jurisdiction two authorities may have separate representations of the same transportation features; differences in scale and applications could mean that some roads are represented by parallel FTSeg for one authority, and by single FTSeg for the other. Each developer will need to make additional application-based decisions about the logical relationship between the single-line and dual-line representations of the same physical transportation segments and the relationship of attributes associated with each, in order to share each others' information. The developers will have to decide whether they can implement the standard by agreeing on a single set of FTRP and FTSeg identifiers, or by agreeing to relate two sets through extensive use of equivalency table records, or a combination of both strategies.*

3.8.1 Implementation Sequence (Overview)

Data developers can establish object identity relationships and connectivity by making the following analysis of their Framework transportation environment:

3.8.1.1 Inventory Transportation Data Organizations and Databases – What organizations maintain transportation data within the geographic extent in question? At its boundaries?

What transportation databases exist within this area? At its boundaries? At what scale, with what spatial accuracy, and with what attribution?

3.8.1.2 Assess Current and Projected Conformance with this Standard – Are these organizations registered Framework Transportation authorities? Do they plan to become authorities?

Do registered FTSeg and FTRP exist within this area? Do registered FTRP exist at its boundaries?

3.8.1.3 Utilize Existing FTSeg and FTRP as much as Practical – Have other Authorities identified FTSeg which represent the same transportation features in your database?

Can you utilize existing FTRP to define new FTSeg, updating FTRP records when helpful, and identifying new FTRP only when necessary?

3.8.2 Implementation Sequence (Detail)

3.8.2.1 Inventory Transportation Data Organizations and Databases

Designation of FTSeg and FTRP should not be undertaken without an understanding of the specific business benefits which will accrue. Most often these are benefits which arise from sharing data with other database developers within the specific geography, and/or from establishing connectivity with transportation databases covering contiguous jurisdictions.

Identification of all organizations which are or may become authorities within and contiguous to the specific geography is necessary to the building of a "business case" for implementing the Standard. The technologies used, business missions, and policy environments of all such organizations should be well-understood, as they impact the ability of organizations to participate in the NSDI Framework. Likewise, all transportation databases which might be pertinent to sharing or connectivity should be inventoried as to scale, accuracy and attribution, in order to better understand the potential costs and benefits of sharing data or connecting to them.

3.8.2.2 Assess Current and Projected Conformance with this Standard

Identification of any transportation databases which are candidates for inclusion in the NSDI Framework should lead to more detailed analysis. A data developer who will implement this Standard should:

3.8.2.2.1 Identify other registered Framework transportation authorities operating within or contiguous to the specific geography;

3.8.2.2.2 Develop thorough FGDC-standardized metadata for Framework transportation databases, and acquire metadata for other candidate databases maintained by other authorities;

3.8.2.2.3 Determine applicability of other relevant standards to the databases, and assess compliance with those standards;

3.8.2.2.4 Determine whether registered FTRP exist within this area, or at its boundaries, and whether FTSeg have already been identified within this area.

3.8.2.3 Utilize Existing FTSeg and FTRP as much as Practical

A data developer should seek to utilize the unique identifiers of all FTRP and FTSeg which describe the same physical transportation features as are represented in the candidate database. A data developer who will implement this Standard should:

3.8.2.3.1 Identify all registered FTRP and FTSeg which exist within and at the boundary of the specific geography

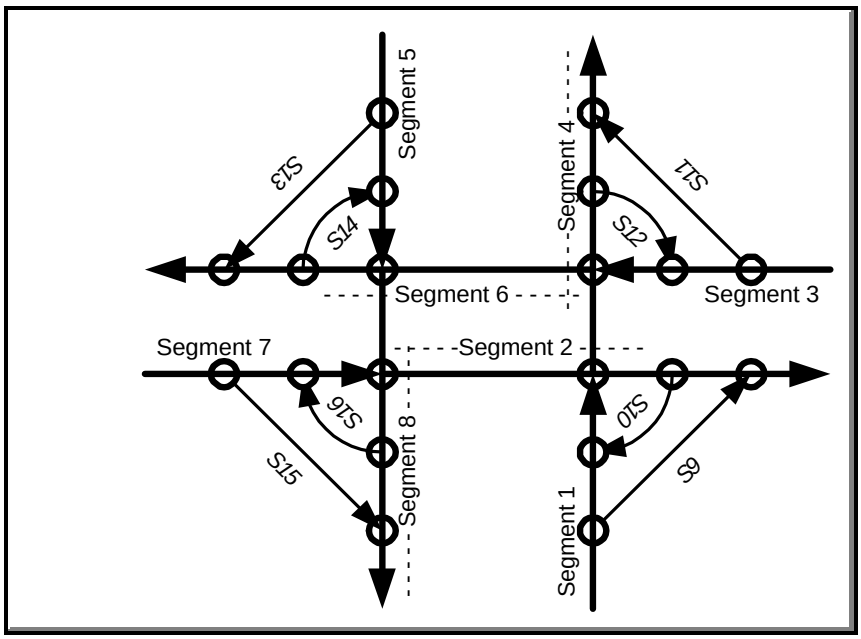

Figure 20 - Utilizing existing FTRP and FTSeg

3.8.2.3.2 Acquire a copy of the database(s) in which FTSeg identifiers are assigned to the spatial data, and encode the same FTSeg on the appropriate segments in the candidate database. *Example: Figure 20 might illustrate FTSeg identified by two different authorities. A developer of a "larger scale" database might implement this Standard in an area where a developer of"intermediate scale" data had already identified Segments 1-8. The first developer should utilize these FTSeg identifiers, updating FTRP records as necessary, and should add new ones only for Segments 9-16.*

3.8.2.3.3 Create new FTRP records only when necessary. FTRP are required as termination points for each FTSeg, required to establish the uniqueness of multiple paths between a pair of FTRP, and may be used at other locations. Creation of new records should follow procedures stated in the following section.

3.9 Conformance Testing

FTSeg and FTRP consist of information which can be structured into tables of information, and then exchanged with others who find the information useful, or combined into larger tables of like information. FTRP and FTSeg may relate to spatial features, objects, or spatial data records contained within individual geographic information systems. Conformance tests are specified in order to assure that the information associated with each FTRP and FTSeg -- and with related attributes -- meets stated content requirements, and that the format of each record is compatible with that used by others who create or update FTSeg and FTRP records.

3.9.1 FTRP and FTSeg Geometry

FTRP and FTSeg are intended to be developed and exchanged without implied geometry; this standard does not include specifications relating to geometry.

3.9.2 Record Content

3.9.2.1 The content of each of the following fields in the FTRP and FTSeg records shall fall within the specified range or domain, as described in Part II of this standard.

3.9.2.1.1 The content of the substrings of unique FTRP and FTSeg identifiers referred to as "AAAAA" and the content of the field "Authority-ID" within FTRP and FTSeg records shall be verifiable when compared against the unique identifiers maintained in the NSDI Framework Authority Index.

3.9.2.1.2 The content of the substrings of unique FTRP and FTSeg identifiers referred to as "O" shall fall within the domain of defined objects: "S" (Segment) or "P" (Point.)

3.9.2.1.3 The content of the substrings of unique FTRP and FTSeg identifiers referred to as "XXXXXXXXX" shall consist of nine alphanumeric characters.

3.9.2.1.4 The content of all date fields shall be valid dates greater that "19990101"

3.9.2.1.5 In records detailing related attributes and equivalency the value of the "End-Offset" shall be greater than the value of the "Start-Offset."

3.9.2.2 The content of other required fields in each FTRP, FTSeg, and related attribute record shall be within specified domains. When not "blank," the content of each

optional field shall be within specified domains. The content of each conditional field shall be within specified domains when the stated condition is "true."

3.9.3 Consistency of FTRP and FTSeg Records

The unique identifiers FTRP named as the From-End-Point and To-End-Point within an FTSeg record must exist within the distributed registry of FTRP, and the unique identifier of the FTSeg-ID required in some FTRP records must exist within the distributed registry of FTSeg.

3.9.4 FTRP and FTSeg Topology

All topological relationships among FTRP and FTSeg are explicitly declared within the Connectivity Table defined in Section 2.4.1 of this standard.

3.9.4.1 At least one record in the Connectivity Table shall contain the unique identifier of each FTSeg and each FTRP.

3.9.4.2 At least two records in the Connectivity Table shall contain the unique identifier of each FTRP at which any connectivity occurs.

3.9.5 Record Format

Data described in this Standard should be exchanged in a common (ASCII) format which can be generated and interpreted by commercial-off-the-shelf (COTS) software.

3.9.5.1 The first line of characters contained in the file should consist of “FTRP” or “FTSeg” or “Attribute” or “Equivalency” or “Authority” , followed by a <Carriage Return / Line Feed> to indicate the type of content in the file.

3.9.5.2 Each record contained in the file should commence on a new line, may be of variable length, and should conclude with <Carriage Return / Line Feed>.

3.9.5.3 Each field should be part of the record -- even if blank (null), and should be of the specified format and length, with the exception of free text fields, which should not exceed the specified length. Each field should be separated from the field preceding and following by a <Tab> character.

3.9.6 Validation

The FGDC will provide computer software which can read and interpret files of information formatted as specified. The software will include a facility for performing all checks on record content specified in this standard, and for providing the user with reports detailing features of particular records which do not meet specifications for content.